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IS/IEC 61241-0 (2004): Electrical apoparatus for use in the presence of compustible dust, Part 0: General requirements [ETD 22: Electrical Apparatus for Explosive Atmosphere]

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[Superseding IS 14154 (Part 1) : 1996]

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दहनशील धूल की उपस्थिति में प्रयोग होने वाले विद्युत के उपस्कर

भाग 0 सामान्य अपेक्षाएँ

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 0 GENERAL REQUIREMENTS

ICS 29.260.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Electrical Apparatus for Explosive Atmospheres Sectional Committee, ETD 22

NATIONAL FOREWORD

This Indian Standard (Part 0) which is identical with IEC 61241-0 : 2004 'Electrical apparatus for use in the presence of combustible dust — Part 0: General requirements' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

This standard supersedes IS 14154 (Part 1) : 1996 'Electrical apparatus with protection by enclosure for use in the presence of combustible dusts: Part 1 Classification for apparatus'.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60034-5 : 2000 Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification	IS 4691 : 1985 Degrees of protection provided by enclosure for rotating electrical machinery (*first revision*)	Technically Equivalent
IEC 60079-0 : 2004 Electrical apparatus for explosive gas atmospheres — Part 0: General requirements	IS/IEC 60079-0 : 2004 Electrical apparatus for explosive gas atmospheres: Part 0 General requirements	Identical
IEC 60079-7 : 2001 Electrical apparatus for explosive gas atmospheres — Part 7: Increased safety "e"	IS 6381 : 2004 Electrical apparatus for explosive gas atmospheres — Increased safety "e" (*first revision*)	do
IEC 60079-11 : 1999 Electrical apparatus for explosive gas atmospheres — Part 11: Intrinsic safety "i"	IS 5780 : 2002 Electrical apparatus for explosive gas atmospheres — Intrinsic safety "i" — Specification (*second revision*)	do
IEC 60086-1 : 2000 Primary batteries — Part 1: General	IS 6303 : 1984 General requirements and methods of tests for dry cells and batteries (*first revision*)	Technically Equivalent

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60216-1 : 2001 Electrical insulating materials — Properties of thermal endurance — Part 1: Ageing procedures and evaluation of test results	IS 8504 (Part 1) : 1994 Guide for determination of thermal endurance properties of electrical insulating materials: Part 1 General guidelines for ageing procedures and evaluation of test results (*first revision*)	Technically Equivalent
IEC 60216-2 : 1990 Guide for the determination of thermal endurance properties of electrical insulating materials — Part 2: Choice of test criteria	IS 8504 (Part 2) : 1983 Guide for determination of thermal endurance properties of electrical insulating materials: Part 2 List of materials and available tests	do
IEC 60285 : 1993 Alkaline secondary cells and batteries — Sealed nickel-cadmium cylindrical rechargeable single cells	IS 14218 : 1994 Sealed cylindrical type rechargeable nickel-cadmium cells	do
IEC 60529 : 1989[1] Degrees of protection provided by enclosures (IP code)	IS 12063 : 1987 Classification of degrees of protection provided by enclosures of electrical equipment	do
IEC 60623 : 2001 Secondary cells and batteries containing alkaline or other non-acid electrolytes — Vented nickel-cadmium prismatic rechargeable single cells	IS 10918 : 1984 Vented type nickel cadmium batteries	do
IEC 60662 : 1980 High-pressure sodium vapour lamps	IS 9974 (Part 1) : 1981 High-pressure sodium vapour lamps: Part 1 General requirements and tests IS 9974 (Part 2) : 1981 High-pressure sodium vapour lamps: Part 2 Standard lamp data sheets	do
IEC 60947-3 : 1999[1] Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units	IS/IEC 60947-3 : 2001 Low-voltage switchgear and controlgear: Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units	do
IEC 61241-1 : 2004 Electrical apparatus for use in the presence of combustible dust — Part 1: Protection by enclosures "tD"	IS/IEC 61241-1 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 1 Protection by enclosures "tD"	Identical
IEC 61241-14 : 2004 Electrical apparatus for use in the presence of combustible dust — Part 14: Selection and installation	IS/IEC 61241-14 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 14 Selection and installation	do

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[1] Since revised in 2001.

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 48 : 1994 Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)	IS 3400 (Part 2) : 2003 Methods of test for vulcanized rubber: Part 2 Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD) (*third revision*)	Identical
ISO 178 : 2001 Plastics — Determination of flexural properties	IS 13360 (Part 5/Sec 7) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 7 Determination of flexural properties	Technically Equivalent
ISO 179 (all parts) Plastics — Determination of Charpy impact properties	IS 13360 (Part 5/Sec 5) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 5 Determination of Charpy impact strength	do
ISO 262 : 1998 ISO General purpose metric screw threads — Selected sizes for screws, bolts and nuts	IS 4218 (Part 4) : 2001 ISO General purpose metric screw threads: Part 4 Selected sizes for screws, bolts and nuts (*second revision*)	Identical
ISO 273 : 1979 Fasteners — Clearance holes for bolts and screws	IS 1821 : 1987 Dimensions for clearance holes for bolts and screws (*third revision*)	do
ISO 286-2 : 1988 ISO System of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts	IS 919 (Part 2) : 1993 ISO System of limits and fits: Part 2 Tables of standard tolerance grades and limit deviations for holes and shafts (*first revision*)	do
ISO 527 (all parts) Plastics — Determination of tensile properties	IS 13360 (Part 5/Sec 1) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 1 Determination of tensile properties — General principles IS 13360 (Part 5/Sec 2) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 2 Determination of tensile properties — Test conditions for moulding and extrusion plastics IS 13360 (Part 5/Sec 25) : 2004 Plastics — Methods of testing: Part 5 Mechanical properties, Section 25 Determination of tensile properties — Test conditions for isotropic and orthotropic fibre-reinforced plastic composites IS 13360 (Part 5/Sec 26) : 2004 Plastics — Methods of testing: Part 5	Technically Equivalent

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
	Mechanical properties, Section 26 Determination of tensile properties — Test conditions for unidirectional fibre-reinforced plastic composit	
ISO 965 (all parts) ISO General purpose metric screw threads — Tolerances	IS 14962 (Part 1) : 2001 ISO General purpose metric screw threads — Tolerances: Part 1 Principles and basic data	Technically Equivalent
	IS 14962 (Part 2) : 2001 ISO General purpose metric screw threads — Tolerances: Part 2 Limits of sizes for general purpose external and internal screw threads – Medium quality	
	IS 14962 (Part 3) : 2001 ISO General purpose metric screw threads — Tolerances: Part 3 Deviations for constructional screw threads	
	IS 14962 (Part 4) : 2001 ISO General purpose metric screw threads — Tolerances: Part 4 Limits of sizes for hot-dip galvanized external screw threads to mate with internal screw threads tapped with tolerance position H or G after galvanizing	
	IS 14962 (Part 5) : 2001 ISO General purpose metric screw threads — Tolerances: Part 5 Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing	
ISO 4014 : 1999 Hexagon head bolts — Product grades A and B	IS 1364 (Part 1) : 2002 Hexagon head bolts, screws and nuts of product grades A and B: Part 1 Hexagon head bolts (size range M 1.6 to M 64) (*fourth revision*)	Identical
ISO 4017 : 1999 Hexagon head screws — Product grades A and B	IS 1364 (Part 2) : 2002 Hexagon head bolts, screws and nuts of product grades A and B: Part 2 Hexagon head screws (size range M 1.6 to M 64) (*fourth revision*)	do
ISO 4026 : 2003 Hexagon socket set screws with flat point	IS 6094 (Part 1) : 2006 Hexagon socket set screws: Part 1 With flat point (*third revision*)	do

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 4027 : 2003 Hexagon socket set screws with cone point	IS 6094 (Part 2) : 2006 Hexagon socket set screws: Part 2 With cone point	Identical
ISO 4028 : 2003 Hexagon socket set screws with dog point	IS 6094 (Part 3) : 2006 Hexagon socket set screws: Part 3 With dog point	do
ISO 4029 : 2003 Hexagon socket set screws with cup point	IS 6094 (Part 4) : 2006 Hexagon socket set screws: Part 4 With cup point (*third revision*)	do
ISO 4032 : 1999 Hexagon nuts, style 1 — Product grades A and B	IS 1364 (Part 3) : 2002 Hexagon head bolts, screws and nuts of product grades A and B: Part 3 Hexagon nuts, style 1 (size range M1.6 to M 64) (*fourth revision*)	do
ISO 4762 : 1997[1] Hexagon socket head cap screws	IS 2269 : 2006 Hexagon socket head cap screws (*fifth revision*)	Technically Equivalent

The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 60095 (all parts)	Lead-acid starter batteries
IEC 60192 : 2001	Low-pressure sodium vapour lamps — Performance specifications
IEC 60243-1 : 1998	Electrical strength of insulating materials — Test methods — Part 1: Test at power frequencies
IEC 61056 (all parts)	General purpose lead-acid batteries (valve-regulated types)
IEC 61150 : 1992	Alkaline secondary cells and batteries — Sealed nickel-cadmium rechargeable monobloc batteries in button cell design
ISO 1818 : 1975[2]	Vulcanized rubbers of low hardness (10 to 35 IRHD) — Determination of hardness
ISO 4892 (all parts)	Plastics — Methods of exposure to laboratory light sources

Only English language text has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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[1] Since revised in 2004.

[2] Withdrawn standard.

INTRODUCTION

Many dusts that are generated, processed, handled and stored, are combustible. When ignited they can burn rapidly and with considerable explosive force if mixed with air in the appropriate proportions. It is often necessary to use electrical apparatus in locations where such combustible materials are present, and suitable precautions must therefore be taken to ensure that all such apparatus is adequately protected so as to reduce the likelihood of ignition of the external explosive atmosphere. In electrical apparatus, potential ignition sources include electrical arcs and sparks, hot surfaces and frictional sparks.

Areas where dust, flyings and fibres in air occur in dangerous quantities are classified as hazardous and are divided into three zones according to the level of risk.

Generally, electrical safety is ensured by the implementation of one of two considerations, i.e. that electrical apparatus be located where reasonably practicable outside hazardous areas, and that electrical apparatus be designed, installed and maintained in accordance with measures recommended for the area in which the apparatus is located.

Combustible dust can be ignited by electrical apparatus in several ways:

- by surfaces of the apparatus that are above the minimum ignition temperature of the dust concerned. The temperature at which a type of dust ignites is a function of the properties of the dust, whether the dust is in a cloud or layer, the thickness of the layer and the geometry of the heat source;
- by arcing or sparking of electrical parts such as switches, contacts, commutators, brushes, or the like;
- by discharge of an accumulated electrostatic charge;
- by radiated energy (e.g. electromagnetic radiation);
- by mechanical sparking or frictional sparking or heating associated with the apparatus.

In order to avoid ignition hazards it is necessary that

- the temperature of surfaces, on which dust can be deposited, or which would be in contact with a dust cloud, is kept below the temperature limitation specified in this standard;
- any electrical sparking parts, or parts having a temperature above the temperature limit specified in IEC 61241-14
    - are contained in an enclosure which adequately prevents the ingress of dust, or
    - the energy of electrical circuits is limited so as to avoid arcs, sparks or temperatures capable to ignite combustible dust;
- any other ignition sources are avoided.

Compliance with this standard will only provide the required level of safety if the electrical apparatus is operated within its rating and is installed and maintained according to the relevant codes of practice or requirements, for example in respect of protection against over-currents, internal short-circuits, and other electrical faults. In particular, it is essential that the severity and duration of an internal or external fault be limited to values that can be sustained by the electrical apparatus without damage.

Several techniques are available for the explosion protection of electrical apparatus in hazardous areas. This standard describes the safety features of these types of explosion-protection techniques and specifies the installation procedures to be adopted. It is most important that the correct selection and installation procedures be followed to ensure the safe use of electrical apparatus in hazardous areas.

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 0 GENERAL REQUIREMENTS

1 Scope

This part of IEC 61241 specifies general requirements for the design, construction, testing and marking of electrical apparatus protected by any recognized safeguard technique for use in areas where combustible dust may be present in quantities that could lead to a fire or explosion hazard.

This standard is supplemented or modified by the following parts of IEC 61241 concerning specific types of protection:

- Part 1: Protection by enclosures 'tD'
- Part 2: Protection by pressurization 'pD' (under consideration)
- Part 11: Intrinsically safe apparatus 'iD'
- Part 18: Protection by encapsulation 'mD'

NOTE IEC 61241-14 gives guidance on the selection and installation of the apparatus. Apparatus within the scope of this standard may also be subjected to additional requirements in other standards – for example, IEC 60079-0.

The application of electrical apparatus in atmospheres which may contain explosive gas as well as combustible dust, whether simultaneously or separately, requires additional protective measures.

This standard does not specify requirements for safety, other than those directly related to the explosion risk.

Where the apparatus has to meet other environmental conditions, for example, protection against ingress of water and resistance to corrosion, additional methods of protection may be necessary. The method used is not to adversely affect the integrity of the enclosure.

This standard does not apply to dusts of explosives that do not require atmospheric oxygen for combustion, or to pyrophoric substances.

This standard is not applicable to electrical apparatus intended for use in underground parts of mines as well as those parts of surface installations of such mines endangered by fire damp and/or combustible dust.

This standard does not take account of any risk due to an emission of flammable or toxic gas from the dust.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-5:2000, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60079-0:2004, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-7:2001, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety 'e'*

IEC 60079-11:1999, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety 'i'*

IEC 60086-1:2000, *Primary batteries – Part 1: General*

IEC 60095 (all parts), *Lead-acid starter batteries*

IEC 60192:2001, *Low-pressure sodium vapour lamps – Performance specifications*

IEC 60216-1:2001, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2:1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 2: Choice of test criteria*

IEC 60243-1:1998, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60285:1993, *Alkaline secondary cells and batteries – Sealed nickel-cadmium cylindrical rechargeable single cells* [4]

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60623:2001, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells*

IEC 60662:1980, *High-pressure sodium vapour lamps*

IEC 60947-3:1999, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 61056 (all parts), *General purpose lead-acid batteries (valve-regulated types)*

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[4] Cancelled and replaced by IEC 61951-1 (2003).

IEC 61150:1992, *Alkaline secondary cells and batteries – Sealed nickel-cadmium rechargeable monobloc batteries in button cell design*

IEC 61241-1:—, *Electrical apparatus for use in the presence of combustible dust – Part 1: Protection by enclosures "tD"*

IEC 61241-14:—, *Electrical apparatus for use in the presence of combustible dust – Part 14: Selection and installation*

ISO 48:1994, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 178:2001, *Plastics – Determination of flexural properties*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

ISO 262:1998, *ISO general-purpose metric screw threads – Selected sizes for screws, bolts and nuts*

ISO 273:1979, *Fasteners – Clearance holes for bolts and screws*

ISO 286-2:1988, *ISO system of limits and fits – Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 527 (all parts), *Plastics – Determination of tensile properties*

ISO 965 (all parts), *ISO general-purpose metric screw threads – Tolerances*

ISO 1818:1975, *Vulcanized rubbers of low hardness (10 to 35 IRHD) – Determination of hardness* [5]

ISO 4014:1999, *Hexagon head bolts – Product grades A and B*

ISO 4017:1999, *Hexagon head screws – Product grades A and B*

ISO 4026:2003, *Hexagon socket set screws with flat point*

ISO 4027:2003, *Hexagon socket set screws with cone point*

ISO 4028:2003, *Hexagon socket set screws with dog point*

ISO 4029:2003, *Hexagon socket set screws with cup point*

ISO 4032:1999, *Hexagon nuts, style 1 – Product grades A and B*

ISO 4762:1997, *Hexagon socket head cap screws*

ISO 4892 (all parts), *Plastics – Methods of exposure to laboratory light sources*

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[5] Withdrawn standard.

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
dust
small solid particles including fibres and flyings in the atmosphere which settle out under their own weight, but which may remain suspended in air for some time (includes dust and grit as defined in ISO 4225)

3.2
combustible dust
dust, fibres or flyings that can burn or glow in air and could form explosive mixtures with air at atmospheric pressure and normal temperatures

3.3
conductive dust
dust, fibres or flyings with electrical resistivity equal to or less than 10^3 Ω·m

3.4
explosive dust atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of dust, fibres or flyings in which, after ignition, combustion spreads throughout the unconsumed mixture

[IEV 426-02-04, modified]

3.5
minimum ignition temperature of a dust layer
lowest temperature of a hot surface at which ignition occurs in a dust layer of specified thickness on this hot surface

[3.3 of IEC 61241-2-1]

3.6
minimum ignition temperature of a dust cloud
lowest temperature of the hot inner wall of a furnace at which ignition occurs in a dust cloud in air contained therein

[3.5 of IEC 61241-2-1, modified]

3.7
electrical apparatus
items applied as a whole or in part for the utilization of electrical energy

NOTE These include, amongst others, items for the generation, transmission, distribution, storage, measurement, regulation, conversion and consumption of electrical energy and items for telecommunications.

3.8
rating
set of rated values and operating conditions

3.9
enclosure
all the walls, doors, covers, cable entries, rods, spindles, shafts, etc. which contribute to the type of protection of and/or the degree of protection (IP) of the electrical apparatus

3.10
dust-tight enclosure
enclosure capable of preventing the ingress of all observable dust particles

3.11
dust-protected enclosure
enclosure in which the ingress of dust is not totally prevented but does not enter in sufficient quantity to interfere with the safe operation of the equipment

NOTE Dust should not accumulate in a position within the enclosure where it is liable to cause an ignition hazard.

3.12
type of protection
specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere by such apparatus

3.13
maximum surface temperature
highest temperature which is attained by any part of the surface of electrical apparatus when tested under the defined dust-free or dust layer conditions at the specified maximum ambient temperature

NOTE This temperature is attained under the test condition. Increasing the layer thickness can increase this temperature due to the thermal insulation properties of dust.

3.14
maximum permissible surface temperature
highest temperature a surface of electrical apparatus is allowed to reach in practical service to avoid ignition

NOTE The maximum permissible surface temperature will depend upon the type of dust, whether as a cloud or layer; if a layer, its thickness, and the application of a safety factor (see IEC 61241-14, Clause 6).

3.15
zones
areas classified for explosive dust atmospheres are divided into zones based upon the frequency and duration of the occurrence of explosive dust/air atmospheres

3.16
Zone 20
place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently

3.17
Zone 21
place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur, occasionally, in normal operation

3.18
Zone 22
place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only

3.19
cable entry
device permitting the introduction of one or more electric and/or fibre optics cables into an electrical apparatus so as to maintain the relevant type of protection

3.20
conduit entry
means of introducing a conduit into an electrical apparatus so as to maintain the relevant type of protection

3.21
compression element
element of a cable entry acting on the sealing ring to enable the latter to fulfil its function

3.22
clamping device
element of a cable entry for preventing tension or torsion in the cable from being transmitted to the connections

3.23
sealing ring
ring used in a cable or conduit entry to ensure the sealing between the entry and the cable or conduit

3.24
terminal compartment
separate compartment or part of a main enclosure, communicating, or not, with the main enclosure, and containing connection facilities

3.25
connection facilities
terminals screws and other parts, used for the electrical connection of conductors of external circuits

3.26
bushing
insulating device carrying one or more conductors through an internal or external wall of an enclosure

3.27
cell
assembly of electrodes and electrolyte that constitutes the smallest electrical unit of a battery

3.28
primary cell or battery
electrochemical system capable of producing electrical energy by chemical reaction

3.29

secondary cell or battery

electrically rechargeable electrochemical system capable of storing electrical energy and delivering it by chemical reaction

3.30

open cell or battery

secondary cell, or battery, having a cover provided with an opening through which gaseous products may escape

[IEC 486-01-18, modified]

3.31

sealed valve-regulated cell or battery

cell or battery which is closed under normal conditions, but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value

NOTE The cell cannot normally receive an addition to the electrolyte.

[IEV 486-01-20, modified]

3.32

sealed gas-tight cell or battery

cell or battery which remains closed and does not release either gas or liquid when operated within the limits of charge or temperature specified by the manufacturer

[IEV 486-01-21, modified]

NOTE 1 Such cells and batteries may be equipped with a safety device to prevent dangerously high internal pressure. The cell or battery does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

NOTE 2 The above definition is taken from EN 50020. It differs from IEV definitions 486-01-20 and IEV 486-01-21 by virtue of the fact it applies to either a cell or battery.

3.33

battery

assembly of two or more cells electrically connected to each other to increase the voltage or capacity

NOTE Where the terms "cell" or "cells" are used, the text refers to individual single cells. Where the terms "battery" or "batteries" are used, the text refers to both cells and batteries.

3.34

capacity

quantity of electricity or electric charge, which a fully charged battery can deliver under specified conditions

3.35

nominal voltage (of a cell or battery)

voltage specified by the manufacturer

3.36

maximum open circuit voltage (of a cell or battery)

voltage which is the maximum attainable voltage under normal conditions, that is, from either a new primary cell, or a secondary cell just after a full charge

NOTE See Table 3 and Table 4 which show the maximum open circuit voltage for acceptable cells.

3.37
charging
act of forcing current through a secondary cell or battery in the opposite direction to the normal flow to restore the energy stored originally

3.38
reverse charging
act of forcing current through either a primary cell or secondary cell in the same direction as the normal flow

NOTE For example, in an expired battery.

3.39
deep discharge
event which reduces a cell voltage below that recommended by the cell or battery manufacturer

3.40
inherently safe (ihs) cell (or battery)
primary cell or battery in which the short-circuit current and maximum surface temperature are limited to a safe value by its internal resistance

3.41
Ex component
part of electrical apparatus for potentially explosive atmospheres, which is not intended to be used alone in such atmospheres and requires additional certification when incorporated into electrical apparatus or systems for use in potentially explosive atmospheres

3.42
"X" symbol
symbol used as a suffix to a certificate reference to denote special conditions for safe use

3.43
"U" symbol
symbol used as a suffix to a certificate reference to denote an Ex component

NOTE The symbols "X" and "U" should not be used together.

3.44
certificate
document confirming that the apparatus is in conformity with the requirements, the type tests and, where appropriate, the routine tests in the standard referred to therein

NOTE 1 A certificate can relate to Ex apparatus or an Ex component.

NOTE 2 A certificate may be produced by the manufacturer, the user, or a third party, for example, an IEC Ex Accepted Certification Body, a national certification body, or an authorized person.

4 Construction

4.1 General

Electrical apparatus for use in potentially explosive dust atmospheres shall comply with the requirements of this standard.

NOTE If the electrical apparatus has to withstand particularly adverse service conditions (for example rough handling, humidity effects, ambient temperature variations, effects of chemical agents, corrosion), these should be specified to the manufacturer by the user and are not the responsibility of the testing station.

4.2 Principles for design and testing of apparatus for use in Zone 20

Apparatus for Zone 20 needs special consideration.

The apparatus shall be designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a very high level of protection.

Apparatus in Zone 20 is intended for use in areas in which explosive atmospheres caused by air/dust mixtures are present continuously, for long periods or frequently. Apparatus in this zone shall ensure the requisite level of protection, even in the event of rare incidents relating to equipment, and is characterized by means of protection such that either

- in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection; or
- the requisite level of protection is assured in the event of two faults occurring independently of each other.

The special requirements for Zone 20 shall be investigated under simulated working conditions as stated by the manufacturer.

NOTE 1 Apparatus for measurement and control techniques (e.g. instrumentation, sensors, controls) are typical applications under dust of excessive layers.

NOTE 2 Power engineering apparatus (such as motors, luminaires, plugs and sockets) should, wherever practicable, be placed outside of such areas.

4.3 Opening enclosures

Enclosures for use in Zone 20 or 21 which can be opened more quickly than the time necessary

- to allow incorporated capacitors, charged by a voltage of 200 V or more, to discharge to a value of residual energy of 0,2 mJ, or residual energy level of 0,4 mJ if the charging voltage is less than 200 V, or
- to allow the cooling of enclosed hot components to a surface temperature below the temperature class of the electrical apparatus

shall be marked with the following or equivalent warning:

"AFTER DE-ENERGIZING, DELAY X MINUTES BEFORE OPENING"

"X" being the value in minutes of the delay required.

Alternatively the apparatus may be marked with the warning:

"DO NOT OPEN WHEN AN EXPLOSIVE DUST ATMOSPHERE IS PRESENT".

4.4 Environmental conditions

Where the apparatus has to meet other environmental conditions, for example, protection against ingress of water and resistance to corrosion, the method of protection used shall not adversely affect the integrity of the enclosure.

5 Temperatures

5.1 Maximum surface temperature

For electrical apparatus, the maximum surface temperature shall be specified in relevant documentation according to 23.2.

This maximum surface temperature shall be arranged and marked according to 29.2 g) and shall be either

- defined by the actual maximum surface temperature, or, if appropriate,
- restricted to the specific combustible dust for which it is intended.

5.2 Maximum surface temperature with respect to dust layers above 50 mm

In addition to the maximum surface temperature required in 5.1, the maximum surface temperature may be stated for a given depth of layer, T_L, of dust surrounding all sides of the apparatus, unless otherwise specified in the documentation, and marked according to 29.2 h).

5.3 Ambient temperature

Electrical apparatus shall normally be designed for use in the ambient temperature range between –20 °C and +40 °C; in this case, no additional marking is necessary.

When the electrical apparatus is designed for use in a different range of ambient temperatures, it is considered to be special; the ambient temperature range shall then be stated by the manufacturer and specified in the certificate; the marking shall then include either the symbol "T_a" or "T_{amb}" together with the special range of ambient temperatures or, if this is impracticable, the symbol "X" shall be placed after the certificate reference, according to 29.2 l) (see Table 1).

Table 1 – Ambient temperatures in service and additional marking

Electrical apparatus	Ambient temperature in service	Additional marking
Normal	Maximum: +40 °C, Minimum: –20 °C	None
Special	Stated by the manufacturer and specified in the certificate	T_a or T_{amb} with the special range, for example "$-30\ °C \leq T_a \leq +40\ °C$" or the symbol "X"

6 Enclosure materials

6.1 Non-metallic enclosures and non-metallic parts of enclosures

The following requirements apply to non-metallic enclosures and non-metallic parts of enclosures on which the type of protection depends. In addition, the requirements of 23.4.6 apply to enclosures for use in Zone 20 or 21.

6.1.1 Material specification

Documents submitted to the manufacturer shall specify both the material and the manufacturing process of the enclosure or part of the enclosure.

6.1.2 Plastic materials

The specification for plastic materials shall include

a) the name of the manufacturer;

b) the exact and complete reference of the material including its colour, percentage of fillers and any other additives if used;

c) the possible surface treatments, such as varnishes, etc.;

d) the temperature index "TI" corresponding to the 20 000 h point on the thermal endurance graph without loss of flexural strength exceeding 50 %, determined in accordance with IEC 60216-1 and IEC 60216-2 and based on the flexing property in accordance with ISO 178. If the material does not break in this test before exposure to the heat, the index shall be based on the tensile strength in accordance with ISO 527 with test bars of Type 1.

The data by which these characteristics are defined shall be supplied by the apparatus manufacturer.

6.1.3 Verification of compliance

The testing station is not required to verify compliance of the material with its specification.

6.1.4 Thermal endurance

6.1.4.1 Temperature index

For Zone 20 and 21 apparatus, the plastic materials shall have a temperature index "TI" corresponding to the 20 000 h point of at least 20 K greater than the temperature of the hottest point of the enclosure or the part of the enclosure (see 23.4.6.1), having regard to the maximum ambient temperature in service.

For Zone 22 apparatus, the plastic materials shall have a temperature index TI corresponding to the 20 000 h point (see IEC 60216-1 and IEC 60216-2) or a continuous operating temperature (COT) of at least 10 K greater than the temperature of the hottest point of the enclosure having regard to the maximum ambient temperature in service according to data supplied by the apparatus manufacturer.

6.1.4.2 Endurance to heat and cold and light

The endurance of the enclosures, or parts of the enclosures, of plastic material to heat, cold and light, shall be satisfactory (see 23.4.6.3, 23.4.6.4 and 23.4.6.5, respectively).

6.1.5 Electrostatic charges

Electrostatic charges on enclosures, or parts of enclosures, of plastic material for use in Zone 20 or 21 shall be limited by the following.

6.1.5.1 Material characteristics

Apparatus of plastic material shall be so designed that under normal conditions of use, danger of ignition due to propagating brush discharges is avoided.

This can be achieved by using plastic, which is not backed with conductive material. If however the plastic is backed by conductive material it shall have one or more of the following characteristics:

- surface resistivity $\leq 10^9\ \Omega$ tested according to 23.4.6.7;
- breakdown voltage ≤ 4 kV (measured across the thickness of the insulating material according to the method described in IEC 60243-1);
- thickness ≥ 8 mm of the external insulation on metal parts. (External plastic layers of 8 mm and greater on metal parts such as measurement probes or similar components make propagating brush discharges unlikely to occur. When evaluating the minimum thickness of the insulation to be used or specified it is necessary to allow for any expected wear under normal usage.)

6.1.5.2 Limited capacitance or grounding

Insulated conductive parts with a capacitance of more than 10 pF shall be avoided or electrostatically grounded.

6.2 Enclosures containing light metals

6.2.1 Composition

Materials used in the construction of enclosures of electrical apparatus to be used in explosive dust atmospheres shall not contain, by weight, more that 7,5 % in total of magnesium and titanium.

6.2.2 Threaded holes

Threaded holes in enclosures for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons may only be tapped in the material of the enclosure when the thread form is compatible with the material used for the enclosure.

7 Fasteners

7.1 Access to live parts

Parts necessary to achieve a standard type of protection or used to prevent access to uninsulated live parts shall be capable of being released or removed only with the aid of a tool.

7.2 Compatible material

Fastening screws for enclosures of materials containing light metals may be made of light metal or plastics if the material of the fastener is compatible with that of the enclosure.

8 Interlocking devices

Interlocking devices used to maintain a type of protection shall be so constructed that their effectiveness cannot readily be defeated by the use, for example, of a screwdriver or pliers.

9 Bushings

9.1 Prevention of turning

Bushings in enclosures used as connection facilities and which may be subjected to a torque while the connection or disconnection is being made shall be mounted in such a way that all parts are secured against turning.

9.2 Torque tests

Bushings in enclosures for use in Zone 20 or 21 shall comply with the relevant torque test as specified in 23.4.4.

10 Materials used for cementing

10.1 Documentation

The manufacturer's documents submitted according to 23.2 shall testify that for the intended operating conditions, the materials used for cementing, and on which safety depends, have a thermal stability adequate for the minimum and maximum temperatures to which they shall be subjected, within the rating of the electrical apparatus.

10.2 Thermal stability

The thermal stability is considered adequate if the limiting values for the material are below or equal to the lowest working temperature and at least 20 K above the maximum temperature in service.

NOTE If the cementing has to withstand adverse service conditions, appropriate measures should be agreed between user and manufacturer.

10.3 Verification

The testing station is not required to verify the characteristics listed in the documents mentioned in 10.1.

11 Ex components

11.1 General

Ex components shall comply with the relevant requirements given in this standard and may be

- an empty enclosure,
- components or assemblies of components for use with apparatus complying with the requirements of one or more of the types of protection listed in Clause 1.

11.2 Mounting

Ex components may be mounted

a) completely within an apparatus enclosure (for example a terminal, ammeter, heater or indicator; a type 'mD' switch component or thermostat or a type 'iD' supply); or

b) completely external to the apparatus enclosure (for example a type 'iD' sensor); or

c) partly within and partly external to the apparatus enclosure (for example a type 'tD' push button switch, a limit switch or indicating lamp, an ammeter or a type 'iD' indicator).

11.3 Internal mounting

In the case of mounting that is completely within the enclosure, the only parts to be tested or assessed when used in an apparatus are those parts that cannot be tested and/or assessed as a separate component (for example test or assessment of surface temperature, creepage distance and clearance, when the component is mounted).

11.4 External mounting

In the case of mounting that is external to the enclosure, or partly within and partly external to the enclosure, the interface between the Ex component and the enclosure shall be tested or assessed for compliance with the relevant type of protection and for compliance with the mechanical tests according to 23.4.2.

12 Connection facilities and terminal compartments

12.1 Attached cables

Electrical apparatus intended for connection to external circuits shall include connection facilities, except where the electrical apparatus is manufactured with a cable permanently connected to it. All apparatus constructed with permanently connected unterminated cables shall be marked with the symbol "X" to indicate the need for appropriate connection of the free end of the cable.

12.2 Terminal access

Terminal compartments and their access openings shall be dimensioned so that the conductors can be readily connected.

12.3 Creepage and clearance

Terminal compartments shall be so designed that after proper connection of the conductors, the creepage distances and the clearances comply with the requirements, if any, of the specific standard for the type of apparatus concerned.

13 Connection facilities for earthing or bonding conductors

13.1 Internal connection

A connection facility for the connection of an earthing or equipotential bonding conductor shall be provided inside the terminal compartment of electrical apparatus and near the other connection facilities.

13.2 External connection

Electrical apparatus with a metallic enclosure shall have an additional external connection facility for an earthing or equipotential bonding conductor. This external connection facility shall be electrically in contact with the facility required in 13.1. The external connection facility is not required for electrical apparatus which is designed to be moved when energized and is supplied by a cable incorporating an earthing or equipotential bonding conductor.

NOTE The expression "electrically in contact" does not necessarily involve the use of a conductor.

13.3 Facility not required

Neither an internal nor external earthing or bonding connection facility is required for electrical apparatus for which earthing (or bonding) is not required, such as electrical apparatus having double or reinforced insulation, or for which supplementary earthing is not necessary.

13.4 Effective connection

Earthing or equipotential bonding connection facilities shall allow for the effective connection of at least one conductor with a cross-sectional area as shown in Table 2.

Table 2 – Minimum cross-sectional areas of protective conductors

Cross-sectional area of phase conductors of the installation, *S* mm^2	**Minimum cross-sectional area of the corresponding protective conductor, *Sp*** mm^2
$S \leq 16$	S
$16 < S \leq 35$	16
$S > 35$	0,5 S

In addition to meeting this requirement, earthing or bonding connection facilities on the outside of electrical apparatus shall provide for effective connection of a conductor of at least 4 mm^2.

13.5 Effective contact

Connection facilities shall effectively be protected against corrosion. They shall also be designed so that the conductors are secured against loosening and twisting and so that the contact pressure is maintained.

13.6 Environmental

Contact pressure of electrical connections shall not be affected by dimensional changes of insulating materials in service, due to temperature or humidity, etc.

13.7 Use of light metal

Special precautions shall be taken if one of the parts in contact consists of a material containing light metal. One example of a means of connecting to a material containing light metal is to use an intermediate part made from steel.

14 Cable and conduit entries

14.1 Intended use

The manufacturer shall specify in the documents submitted according to 23.2 the entries intended for use with cable or conduit, their position on the apparatus and the maximum number permitted.

14.2 Construction

Cable and conduit entries shall be constructed and fixed so that they do not alter the specific characteristics of the type of protection of the electrical apparatus on which they are mounted. This shall apply to the whole range of cable dimensions specified by the manufacturer of the cable entries as suitable for use with those entries.

14.3 Integral part of the apparatus

Cable and conduit entries may form an integral part of the apparatus, i.e. one major element or part forms an inseparable part of the enclosure of the apparatus. In such cases the entries shall be tested and certified with the apparatus.

NOTE Cable and conduit entries, which are separate from, but installed with the apparatus, are usually tested and certified separately from the apparatus but may be tested and certified together with the apparatus if the apparatus manufacturer so requests.

14.4 Prevention of twisting

Where the design of a cable entry is such that twisting of the cable can be transmitted to the connections, then means shall be provided to prevent such twisting.

14.5 Method of attaching

Entry by conduit or cable entries shall be either by screwing into threaded holes or by locking in plain holes

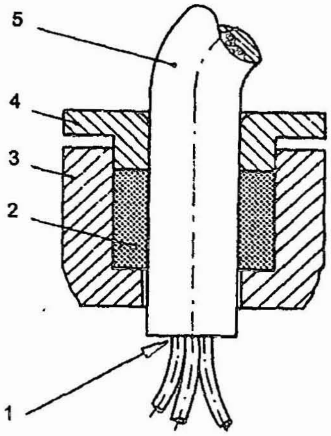
- in the wall of the enclosure, or
- in an adaptor plate designed to be fitted in or on the walls of the enclosure, or
- into a suitable stopping box, integral with or attached to the wall of the enclosure.

14.6 Blanking elements

Blanking elements intended to close openings in the walls of electrical apparatus when they are not fitted with cable or conduit entries shall, together with the enclosure wall of the apparatus, satisfy the requirements of the specific type of protection concerned. The means provided for this shall be such that the blanking element can be removed only with the aid of a tool.

14.7 Branching point temperatures

When the temperature under rated conditions, including any manufacturer's installation requirements, is higher than 70 °C at the cable or conduit entry point, or 80 °C at the branching point of the conductors, the outside of the electrical apparatus shall be marked as a guide for the selection by the user of the cable or of the wiring in the conduit, in order to ensure that the rated temperature of the cable is not exceeded (see Figure 1).



Key

1) Branching point of the conductors
2) Sealing ring
3) Cable entry body
4) Clamping ring with curved rim
5) Cable

Figure 1 – Illustration of entry points and branching points

15 Radiating equipment

The energy levels of radiation generating equipment shall not exceed the values given below (see IEC 61241-14).

15.1 Lasers and other continuous wave source

15.1.1 Zone 20 and Zone 21

Radiation-generating electrical equipment, if tested and permitted in accordance with this specification for Zone 20 or 21, may be used. Independently of this fact it shall be ensured that irradiation power or irradiation that may penetrate into or occur in Zone 20 or 21, even in the case of rare disturbances in the entire part of the radiation process proceeding in Zone 20 or 21 and at any point in the radiation cross-section, shall not exceed the following values:

- 5 mW/mm^2 or 35 mW for continuous wave lasers and other continuous wave sources, and
- 0,1 mJ/mm^2 for pulse lasers or pulse light sources with pulse intervals of at least 5 s.

Radiation sources with pulse intervals of less than 5 s are regarded as continuous light sources in this respect.

15.1.2 Zone 22

Equipment generating radiation may be used. The irradiation intensity or irradiation shall not exceed 10 mW/mm^2 or 35 mW continuous and 0,5 mJ/mm^2 for pulse in normal operation.

15.2 Ultrasonic sources

For ultrasonic sources the power level shall not exceed a power density in the sound field of 0,1 W/cm^2 and a frequency of 10 MHz for continuous sources and 2 mJ/cm^2 for pulse sources. The average power density shall not exceed 0,1 W/cm^2.

15.2.1 Zone 20 and Zone 21

In Zone 20 or 21, ultrasonics sources shall not exceed a power density in the sound field of 0,1 W/cm^2 and a frequency of 10 MHz for continuous sources and 2 mJ/cm^2 for pulse sources. The average power density shall not exceed 0,1 W/cm^2.

15.2.2 Zone 22

In Zone 22 no special safety measures against ignition hazards due to the use of ultrasonics themselves are necessary, provided the power density in the sound field generated does not exceed 0,1 W/cm^2 and an installed frequency of 10 MHz.

16 Supplementary requirements for specific electrical apparatus – Rotating electrical machines

External, shaft driven cooling fans of rotating electrical machines shall be enclosed by a fanhood, which is not considered to be part of the enclosure of the electrical apparatus. Such fans and fanhoods shall meet the following requirements.

16.1 Ventilation openings for external fans

The degree of protection (IP) of ventilation openings for external fans of rotating electrical machines shall be at least

- IP20 on the air inlet side,
- IP10 on the air outlet side,

according to IEC 60034-5.

For vertical rotating machines for use in Zone 20 or 21, foreign objects shall be prevented from falling into the ventilation openings.

16.2 Construction and mounting of the ventilating systems

Fans, fanhoods and ventilation screens shall be constructed so as to meet the requirements of the resistance to impact test according to 23.4.2.1.

16.3 Clearances for the ventilating system for use in Zone 20 or 21

In normal operation the clearances, taking into account design tolerances, between the external fan and its hood, ventilation screens and their fasteners shall be at least one hundredth of the maximum diameter of the fan, except that the clearances need not exceed 5 mm and may be reduced to 1 mm if the opposing parts are manufactured so as to have dimensional accuracy and stability. In no case shall the clearance be less than 1 mm.

16.4 Materials for external fans and fanhoods

16.4.1 Electrostatic discharge

External fans, fanhoods, ventilation screens, etc., shall have an electrical insulation resistance measured according to 6.1.5.1 not exceeding 10^9 Ω.

16.4.2 Thermal stability of plastic materials for use in Zones 20 and 21

The thermal stability of plastic materials shall be considered adequate if the manufacturer's specified operating temperature of the material exceeds the maximum temperature to which the material will be subjected in service (within the rating) by at least 20 K.

16.4.3 Materials containing light metals for use in Zones 20 and 21

The external fans, fanhoods and ventilation screens of rotating electrical machines manufactured from materials containing light metals shall not contain by weight more than 7,5 % of magnesium.

17 Switchgear

17.1 Flammable dielectric

Switchgear with contacts immersed in flammable dielectric is not permitted.

17.2 Interlocking

Disconnectors (which are not designed to be operated under the intended load) shall

- be electrically or mechanically interlocked with a suitable load breaking device, or
- be marked at a place near the actuator of the disconnector, with the warning

"DO NOT OPERATE UNDER LOAD".

17.3 Indication of open position

Where switchgear includes a disconnector, the latter shall disconnect all poles and shall be designed so that the position of the disconnector contacts is visible, or their open position is indicated in accordance with the requirements for the isolation function specified in IEC 60947-3. Any interlock between such disconnector and the cover or door of the switchgear shall allow this cover or door to be opened only when the separation of the disconnector contacts is effective.

17.4 Openings

Doors and covers giving access to the interior of enclosures containing remotely operated circuits with switching contacts which can be made or broken by non-manual influences (such as electrical, mechanical, magnetic, electro-magnetic, electro-optical, pneumatic, hydraulic, acoustic or thermal) shall either

- be interlocked with a disconnector which prevents access to the interior unless it has been operated to disconnect unprotected internal circuits; or
- the apparatus shall be marked with the warning:

"DO NOT OPEN WHEN ENERGIZED".

18 Fuses

Enclosures containing fuses shall either

- be interlocked so that insertion or removal of replaceable elements can be carried out only with the supply disconnected and so that the fuses cannot be energized until the enclosure is correctly closed; or alternatively
- the apparatus shall be marked with the warning

"DO NOT OPEN WHEN ENERGIZED".

19 Plugs and sockets

The requirements for plugs and sockets are not applicable for type of protection Ex iD.

19.1 Plugs and sockets construction

Plugs and sockets shall comply with either a) or b) below:

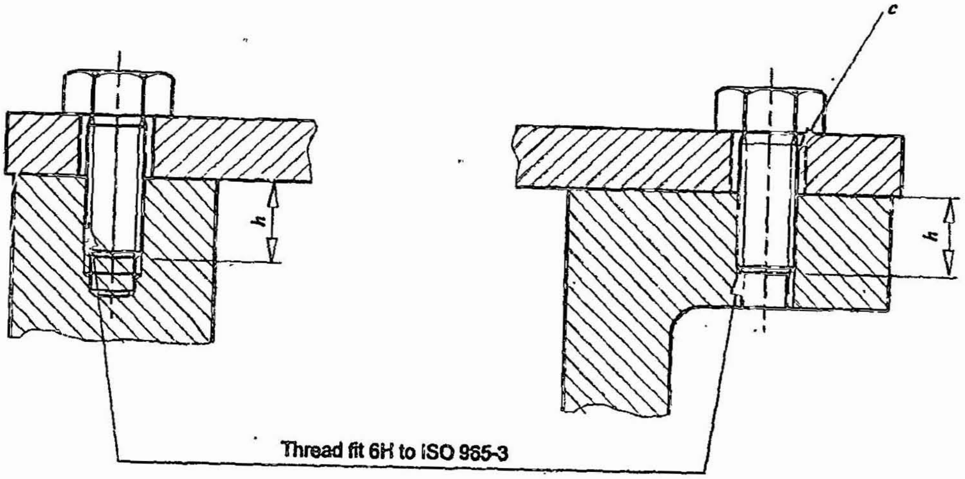
a) be interlocked mechanically, or electrically, or otherwise designed so that they cannot be separated when the contacts are energized and the contacts cannot be energized when the plug and socket are separated; or

b) be fixed together by means of special fasteners that shall conform to the following:

   - the thread shall be coarse pitch in accordance with ISO 262, with a tolerance fit of 6g/6H in accordance with ISO 965;
   - the head of the screw or nut shall be in accordance with ISO 4014, ISO 4017, ISO 4032 or ISO 4762, and in the case of hexagon socket set screws ISO 4026, ISO 4027, ISO 4028 or ISO 4029;
   - the holes of the electrical apparatus shall be threaded for a distance to accept a thread engagement, h, at least equal to the major diameter of the thread of the fastener (see Figures 2 and 3).

The thread shall have a tolerance fit of 6H in accordance with ISO 965, and either

1) the hole under the head of the associated fastener shall allow a clearance not greater than a medium tolerance fit of H13 in accordance with ISO 286-2 (see Figure 2 and ISO 273); or
2) the hole under the head (or nut) of an associated reduced shank fastener shall be threaded to enable the fastener to be retained. The dimensions of the threaded hole shall be such that the surrounding surface in contact with the head of such a fastener shall be at least equal to that of a fastener without a reduced shank in a clearance hole (see Figure 3).

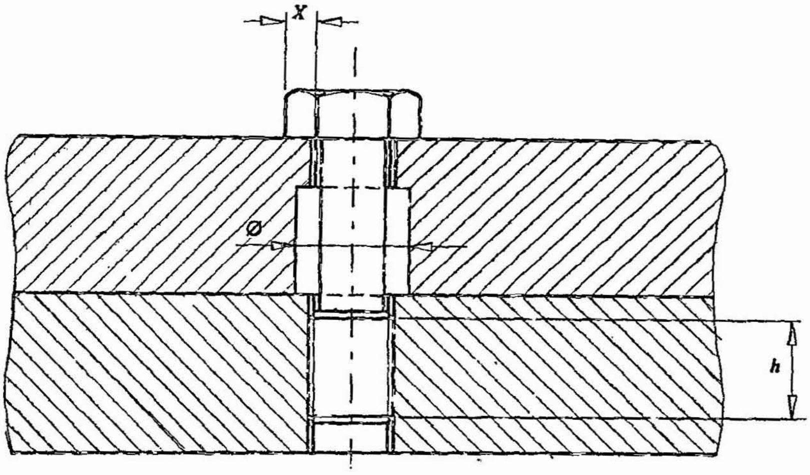


Key

$h \geq$ major diameter of the thread of the fastener

$c \leq$ maximum clearance permitted by tolerance of fit H13 of ISO 286-2

Figure 2 – Tolerances and clearance for threaded fasteners



Key

Ø	standard clearance hole appropriate to the threadform
$h \geq$	major diameter of the thread of the fastener
X	the contact dimension of a reduced shank fastener
$X \geq$	the contact dimension of a standard head of a standard fastener (without reduced shank) threaded throughout its length with the size of thread used

Figure 3 – Contact surface under head of fastener with a reduced shank

In the case of hexagon socket set screws, the screw head shall have a tolerance fit of 6H in accordance with ISO 965 but shall not protrude from the threaded hole after tightening, and the apparatus marked with the warning

"DO NOT SEPARATE WHEN ENERGIZED".

19.2 Bolted plugs and sockets

Where bolted types cannot be de-energized before separation because they are connected to a battery, the marking shall then state

"SEPARATE ONLY WHEN A HAZARD DOES NOT EXIST".

19.3 For Zone 21 and Zone 22

Plugs and sockets for rated currents not exceeding 10 A and rated voltage not exceeding either 250 V a.c. or 60 V d.c. need not comply with the requirements of 19.1 if all the following conditions are complied with, i.e:

- the part which remains energized is a socket outlet;
- the plug and socket break the rated current with delayed release to permit the arc to be extinguished before separation;
- the plug and socket remain dust tight to IP 6X during the arc-quenching period.

19.4 Plugs remaining energized

With the exception of Ex iD, plugs and components remaining energized when not engaged with a socket are not permitted.

20 Luminaires

20.1 Light transmitting covers

The source of light of luminaires shall be protected by a light-transmitting cover, which may be provided with an additional guard comprising a mesh not greater than 50 mm^2. If mesh sizes exceed 50 mm^2, then the luminaire cover shall be considered as unguarded.

20.2 Guards

The light transmitting cover and, if provided, the guard, shall be capable of passing the relevant tests according to 23.4.2.1.

20.3 Mounting

The mounting of luminaires shall not depend on a single screw. A single eyebolt may be used only if this is an integral part of the luminaire, for example by being cast or welded to the enclosure, or, if threaded, the eyebolt is locked by a separate means against loosening when twisted.

20.4 Covers

Except in the case of intrinsically safe luminaires to IEC 60079-11, covers giving access to the lampholder and other internal parts of luminaries shall either

a) be interlocked with a device which automatically disconnects all poles of the lampholder as soon as the cover opening procedure begins; or

b) be marked with the warning

"DO NOT OPEN WHEN ENERGIZED".

20.5 Parts remaining energized

In the case of 20.4 a), where it is intended that some parts other than the lampholder will remain energized after operation of the disconnecting device, then in order to minimize the risk of explosion, those energized parts shall be protected by

- clearances and creepage distances between phases (poles) and to earth in accordance with the requirements of IEC 60079-7; and
- an internal supplementary enclosure (which can be the reflector for the light source) which contains the energized parts and provides a degree of protection of at least IP30, according to IEC 60529; and
- marking on the internal supplementary enclosure with the warning

"DO NOT OPEN WHEN ENERGIZED".

20.6 Types of lamps

Lamps containing free metallic sodium (for example low-pressure sodium lamps in accordance with IEC 60192) are not permitted. High-pressure sodium lamps (for example in accordance with IEC 60662) may be used.

21 Caplights, caplamps and handlamps

21.1 Leakage

Leakage of the electrolyte shall be prevented in all positions of the apparatus.

NOTE The materials used for handlamps and caplights, which may be exposed to the electrolyte, should be chemically resistant to the electrolyte.

21.2 Separate enclosures

Where the source of light and the source of supply are housed in separate enclosures, which are not mechanically connected other than by an electric cable, the cable entries and the connecting cable shall be tested as appropriate according to Clause 27 or Clause 28.

22 Apparatus incorporating cells and batteries

22.1 General

The requirements in 22.2 to 22.13 below shall apply for all cells and batteries incorporated into explosion protected apparatus.

22.2 Connection of cells

Batteries incorporated into explosion-protected apparatus shall be formed only from cells connected in simple series.

22.3 Characteristics

Only cell types referred to in published IEC cell standards and having known characteristics shall be used. Table 3 and Table 4 below list cells for which suitable standards either exist, or are to be produced.

Table 3 – Primary cells

IEC 60086-1 Type	Positive electrode	Electrolyte	Negative electrode	Nominal voltage V	Maximum open circuit voltage V
–	Manganese dioxide	Ammonium chloride, zinc chloride	Zinc	1,5	1,73
A	Oxygen	Ammonium chloride, zinc chloride	Zinc	1,4	1,55
B	Carbon monofluoride	Organic electrolyte	Lithium	3	3,7
C	Manganese dioxide	Organic electrolyte	Lithium	3	3,7
E	Thionyl chloride ($SOCl_2$)	Non-aqueous inorganic	Lithium	3,6	3,9
F	Iron disulfide (FeS_2)	Organic electrolyte	Lithium	1,5	1,83
G	Copper (II) oxide (CuO)	Organic electrolyte	Lithium	1,5	2,3
L	Manganese dioxide	Alkali metal hydroxide	Zinc	1,5	1,65
P	Oxygen	Alkali metal hydroxide	Zinc	1,4	1,68
S	Silver oxide (Ag_2O)	Alkali metal hydroxide	Zinc	1,55	1,63
T	Silver oxide (AgO, Ag_2O)	Alkali metal hydroxide	Zinc	1,55	1,87
[a]	Sulphur dioxide	Non-aqueous organic salt	Lithium	3,0	3,0
[a]	Mercury	Alkali metal hydroxide	Zinc	Data awaited	Data awaited

[a] May only be used once an IEC cell standard exists.

NOTE Zinc/manganese dioxide cells are listed in IEC 60086-1 but not classified by a type letter.

Table 4 — Secondary cells

Relevant IEC type	Type	Electrolyte	Nominal voltage V	Maximum open circuit voltage V
Type K				
IEC 61056	Lead-acid (wet)	Sulphuric acid (SG 1,25)	2,2	2,67
IEC 60095	Lead-acid (dry)		2,2	2,35
Type K IEC 60285 IEC 60623 IEC 60662 IEC 61150	Nickel-cadmium	Potassium hydroxide (SG1,3)	1,2	1,55
[a]	Nickel-iron	Potassium hydroxide (SG1,3)	Data awaited	1,6
[a]	Lithium	Non-aqueous organic salt	Data awaited	Data awaited
[a]	Nickel metal hydride	Potassium hydroxide	1,2	1,5

[a] May only be used once an IEC cell standard exists.

22.4 Compatibility

All cells in a battery shall be of the same electrochemical system, cell design and rated capacity.

22.5 Limits

All batteries shall be arranged and operated so as to be within the allowable limits defined by the cell or battery manufacturer.

22.6 Mixture of cells

Batteries shall not contain a mixture of primary and secondary cells.

22.7 Interchangeability

Primary and secondary cells or batteries shall not be used inside the same apparatus enclosure if they are readily interchangeable.

22.8 Re-charging

Primary batteries shall not be re-charged. Where another voltage source exists inside apparatus containing primary batteries and there is a possibility of interconnection, precautions shall be taken to prevent charging current passing through them.

22.9 Different cells

Batteries shall not contain cells made by different manufacturers.

22.10 Leakage

All cells shall be constructed or arranged so as to prevent leakage of electrolyte which would adversely affect the type of protection or components on which safety depends.

22.11 Method of connection

Only the manufacturer's recommended method(s) of making electrical connections to a battery shall be used.

22.12 Orientation

Where a battery is mounted inside apparatus and its orientation is important for safe operation, the correct orientation of the apparatus shall be indicated on the outside of the apparatus enclosure.

22.13 Identification of replacement

Where it is necessary for the user to replace cells or batteries contained within an enclosure, the relevant parameters to allow correct replacement shall be legibly and durably marked on or inside the enclosure, or detailed in the manufacturer's instructions; that is, either the manufacturer's part number, or the name of the cell or battery manufacturer, the electrochemical system, nominal voltage and rated capacity.

23 Verification and tests

23.1 General

The type verifications and tests are intended to verify that a prototype or sample of the electrical apparatus complies with the relevant requirements of this standard.

23.2 Verification of documents

23.2.1 General

It shall be verified that documents submitted by the manufacturer give a full and correct specification of the safety aspects of the electrical apparatus.

23.2.2 Compliance with standards

It shall also be verified that in the design of the electrical apparatus the requirements of this standard and of the specific standards for the types of protection concerned have been observed.

23.3 Compliance of prototype or sample with documents

It shall be verified that the prototype or sample of the electrical apparatus submitted for the type tests complies with the manufacturer's documents referred to above.

23.4 Type tests

23.4.1 General

The prototype or sample shall be tested in accordance with the requirements for type tests of this standard. However, the responsible party

- may omit certain tests judged to be unnecessary. A record of all tests carried out and the justification for those omitted shall be kept;
- shall not conduct the tests which have already been carried out on an Ex component.

For tests required to be carried out by a testing station, the tests shall be made either in the laboratory of the testing station or, subject to agreement between the testing station and the manufacturer, elsewhere under the supervision of the testing station, for example at the manufacturer's works.

Each test shall be made in that configuration of the apparatus, which is considered to be the most unfavourable.

23.4.2 Mechanical tests

23.4.2.1 Test for resistance to impact

In this test the electrical apparatus is submitted to the effect of a test mass of 1 kg falling vertically from a height h. The height h is dependent on the impact energy E, which is specified in Table 5 according to the application of the electrical apparatus ($h = E/10$; h in metres and E in joules). The test mass shall be fitted with an impact head in hardened steel in the form of a hemisphere 25 mm in diameter.

Before each test, it is necessary to check that the surface of the impact head is in good condition.

Normally the resistance to the impact test is made on apparatus which is completely assembled and ready for use; however, if this is not possible (e.g. for light-transmitting parts) the test is made with the relevant parts removed but fixed in their mounting or an equivalent frame. Tests on an empty enclosure are permitted only if there has been prior agreement between the manufacturer and testing station.

For light-transmitting parts made of glass, the test shall be made on three samples but only once on each. In all other cases the test shall be made on two samples, at two separate places on each sample.

The points of impact shall be the places considered by the testing station, or as agreed by the manufacturer and purchaser, to be the weakest. The electrical apparatus shall be mounted on a steel base so that the direction of the impact is normal to the surface being tested if it is flat, or normal to the tangent to the surface at the point of impact if it is not flat. The base shall have a mass of at least 20 kg or be rigidly fixed or inserted in the floor (secured in concrete, for example).

Table 5 – Tests of resistance to impact

Risk of mechanical danger	Impact energy (joules)	
	High	**Low**
1. Guards, protective covers, fanhoods, cable entries	7	4
2. Plastic enclosures	7	4
3. Light metal or cast metal enclosures	7	4
4. Enclosures of materials not included in row 3 with wall thickness less than 1 mm	7	4
5. Light-transmitting parts without guard	4	2
6. Light transmitting parts with guard (tested without guard)	2	1

When an electrical apparatus is submitted to tests corresponding to the low risk of mechanical danger, it shall be marked with the symbol "X" according to 29.2.

Normally the test is carried out at an ambient temperature of (20 ± 5) °C, except where the material data shows it to have a reduction in resistance to impact at lower temperatures within the specified ambient range, in which case the test shall be performed at the lowest temperature within the specified range.

When the electrical apparatus has an enclosure or a part of an enclosure in plastic material, including plastic fanhoods and ventilation screens in rotating electrical machines, the test shall be carried out at the upper and lower temperatures according to 23.4.6.1.

23.4.2.2 Drop test

In addition to being submitted to the resistance to impact test according to 23.4.2.1, hand-held electrical apparatus or electrical apparatus carried on the person, ready for use, shall be dropped four times from a height of 1 m onto a horizontal concrete surface. The position of the sample for the drop test shall be selected by the testing station, or as agreed by the manufacturer and purchaser.

For apparatus with an enclosure in other than plastic material, the test shall be carried out at a temperature of (20 ± 5) °C, except where the material data shows it to have a reduction in resistance to impact at lower temperatures within the specified ambient range, in which case the test shall be performed at the lowest temperature within the specified range.

For electrical apparatus with enclosures or parts of enclosures made of plastic material, the tests shall be carried out at the lower ambient temperature according to 23.4.6.1.

23.4.2.3 Verification

The resistance to impact and drop tests shall not produce damage invalidating the type of protection of the electrical apparatus.

Superficial damage, chipping to paint work, breakage of cooling fins or other similar parts of the electrical apparatus, and small dents shall be ignored.

External fanhoods and ventilation screens shall resist the tests without displacement or deformation causing rubbing by the moving parts.

23.4.3 Test for dust exclusion (degree of protection)

Depending on the environmental conditions likely to be encountered (such as area classification and conductivity of dust) two levels of dust exclusion efficiency have been adopted: "dust-tight" and "dust-protected" enclosures. Applicable levels of dust exclusion are dependant on the type of protection employed and specified in the applicable part of the IEC 61241 series for that type of protection.

NOTE For the required degree of dust exclusion efficiency, see IEC 61241-14.

23.4.4 Torque test for bushings in enclosures for use in Zone 20 or 21

Threaded bushings in enclosures shall meet the torque requirements listed in Table 6.

Table 6 – Torque to be applied to the stem of bushing used for connection facilities

Bushing size	Torque Nm
M4	2,0
M5	3,2
M6	5
M8	10
M10	16
M12	25
M16	50
M20	85
M24	130

NOTE Torque values for sizes other than those specified above may be determined from a graph, plotted using these values. In addition, the graph may be extrapolated to allow torque values to be determined for bushings larger than those specified.

23.4.5 Thermal tests

23.4.5.1 Measurement for maximum surface temperature

The thermal tests shall be made at the rating of the electrical apparatus at an ambient temperature between 10 °C and 40 °C and with the most unfavourable voltage between 90 % and 110 % of the rated voltage of the electrical apparatus, unless other IEC publications prescribe other tolerances for equivalent industrial electrical apparatus.

The test shall be made under the most adverse conditions, including overloads and recognized abnormal conditions that may be specified in an IEC standard giving specific requirements for the electrical apparatus concerned. Adverse conditions may also arise from the use of electrical apparatus on inverter supplies, frequent starting, etc.

For Zone 20, the adverse conditions shall take into account two simultaneous faults or rare malfunctions; for Zone 21, foreseeable malfunctions; and for Zone 22, normal operation applies.

The measurement of the surface temperatures shall be made with the electrical apparatus mounted in its normal service position.

For electrical apparatus, which can be normally used in different positions, the temperature in each position shall be determined and the highest temperature considered. When the temperature is determined for certain positions, only this shall be specified in the test report and the electrical apparatus shall be marked accordingly.

The measuring devices (thermometers, thermocouple, etc.) and the connecting cables shall be selected and so arranged that they do not significantly affect the thermal behaviour of the electrical apparatus.

The final temperature is considered to have been reached when the rate of rise of temperature does not exceed 2 K/h.

23.4.5.2 Measurement for surface temperature under excess layer

If the requirements of 5.2 apply, then the electrical apparatus to be tested shall be mounted and surrounded by a layer depth L as stated by the manufacturer's specification. The measurement for the maximum surface temperature shall be made according to 23.4.5.1 using a dust having a thermal conductivity of no more than 0,003 kcal/m °C·h.

23.4.5.3 Temperature control

Some apparatus may require the provision of integral temperature sensitive devices, e.g. certain electric motors, fluorescent luminaires, etc. The effect of such devices shall be tested under simulated working conditions. This protection shall be subject to consideration of faults and malfunction according to 23.4.5.1 according to the intended zone of use.

23.4.6 Thermal shock test

Glass parts of luminaires and windows of electrical apparatus shall withstand, without breaking, a thermal shock caused by a jet of water about 1 mm in diameter at a temperature of (10 ± 5) °C sprayed on them when they are at maximum service temperature.

23.4.7 Tests of non-metallic enclosures or of non-metallic parts of apparatus for use in Zone 20 or 21

23.4.7.1 Ambient temperatures during tests

When, according to this standard, tests have to be made as a function of the permissible upper and lower ambient temperature values, these ambient temperatures shall be

- for the upper ambient temperature, the maximum ambient temperature in service increased by at least 10 K but at most 15 K;
- for the lower ambient temperature, the minimum ambient temperature in service reduced by at least 5 K but at most 10 K.

23.4.7.2 Tests of enclosures or parts of enclosures in plastic materials

These tests shall be made on two samples which shall be submitted to the tests of thermal endurance to heat (see 23.4.7.3), thermal endurance to cold (see 23.4.7.4) and mechanical tests (see 23.4.7.6) and finally to the tests specific to the type of protection concerned.

23.4.7.3 Thermal endurance to heat

Thermal endurance to heat is determined by submitting the enclosures or parts of enclosures in plastic materials on which the integrity of the type of protection depends to continuous storage for four weeks in an ambience of (90 ± 5) % relative humidity and at a temperature of (20 ± 2) K above the maximum service temperature, but at least 80 °C.

In the case of a maximum service temperature above 75 °C, the period of four weeks specified above shall be replaced by a period of two weeks at (95 ± 2) °C and (90 ± 5) % relative humidity followed by a period of two weeks at a temperature of (20 ± 2) K higher than the maximum service temperature.

23.4.7.4 Thermal endurance to cold

Thermal endurance to cold is determined by submitting the enclosures and parts of enclosures in plastic materials on which the type of protection depends to storage for 24 h in an ambient temperature corresponding to the minimum service temperature, reduced according to 23.4.7.1.

23.4.7.5 Resistance to light

23.4.7.5.1 General

A test of resistance of the material to light shall be made only if the enclosure or parts of the enclosure made of plastics materials are not protected from light.

The test shall be made on six test bars of standard size 50 mm x 6 mm x 4 mm according to ISO 179. The test bars are to be made under the same conditions as those used for the manufacture of the enclosure concerned; these conditions are to be stated in the test report of the electrical apparatus.

The test shall be made in accordance with ISO 4892 in an exposure chamber using a xenon lamp and a sunlight simulating filter system, at a black panel temperature of (55 ± 3) °C. The exposure time shall be 1 000 h.

The evaluation criterion is the impact bending strength in accordance with ISO 179. The impact bending strength following exposure in the case of an impact on the exposed side shall be at least 50 % of the corresponding value measured on the unexposed test pieces. For materials whose impact bending strength cannot be determined prior to exposure because no rupture has occurred, not more than three of the exposed test bars may break.

23.4.7.5.2 Tests not applied

If the apparatus is protected from light (for example daylight or light from luminaires) when installed, and the test of 23.4.7.5.1 in consequence is not carried out, the apparatus shall be 'X' marked.

23.4.7.6 Mechanical tests

The mechanical tests specified in 23.4.2 shall be carried out on the enclosures and, additionally, in the case of plastic enclosures, according to 23.4.7.2.

The following detailed conditions shall be observed:

a) test for resistance to impact

   The places of impact shall be on the external parts exposed to impact. If the enclosure of non-metallic material is protected by another enclosure, only the external parts of the assembly shall be subjected to the resistance to impact tests.

   The test shall first be made at the highest temperature, then at the lowest temperature, according to 23.4.7.1.

b) drop test

   The drop test for electrical apparatus which is held in the hand or carried on the person, shall be made at the lowest temperatures, according to 23.4.7.1.

23.4.7.7 Surface resistivity test

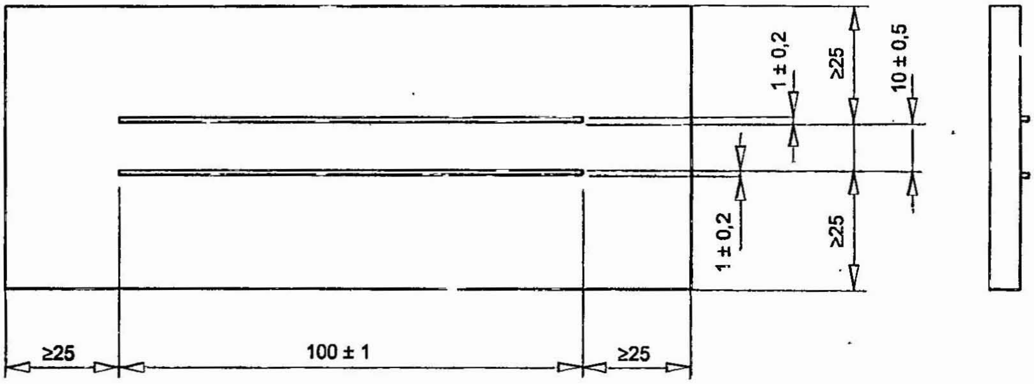
The surface resistivity is tested on the parts of enclosures if size permits, or on a test piece comprising a rectangular plate with dimensions in accordance with Figure 4, on which two parallel electrodes are painted on the surface, using a conducting paint with a solvent that has no significant effect on the surface resistivity.

The test piece shall have an intact surface and shall be cleaned with distilled water, then with isopropyl alcohol (or any other solvent that can be mixed with water and will not affect the material of the test piece), then once more with distilled water before being dried. Untouched by bare hands, it shall then be conditioned for 24 h at the temperature and humidity according to 7.3 of IEC 60079-0. The test shall be carried out under ambient conditions.

The direct voltage applied for 1 min between the electrodes shall be equal to (500 ± 10) V.

During the test, the voltage shall be sufficiently steady so that the charging current due to voltage fluctuation is negligible compared with the current flowing through the test piece.

The surface resistivity is the quotient of the direct voltage applied at the electrodes to the total current flowing between them when the voltage has been applied for 1 min.



Dimensions in millimetres

Figure 4 – Test piece with painted electrodes

23.4.7.8 Ageing test for material used for elastomeric sealing rings

The material used for the manufacture of the sealing rings is prepared in the form of test pieces in accordance with ISO 48 and ISO 1818; the hardness is determined in accordance with the same standards at ambient temperature.

The test piece is then placed in an oven in which the temperature is maintained at (100 ± 5) °C for at least 168 h without interruption; they are then kept for at least 24 h at ambient temperature, then placed in a refrigerator in which the temperature is maintained at (–20 ± 2) °C for at least 48 h without interruption; they are finally kept for at least 24 h at ambient temperature. The hardness is then determined again.

At the end of the test procedure the variation in hardness, expressed in IRHD (international rubber hardness degree) units as specified in the ISO standards given above, shall not exceed 20 % of the hardness before ageing.

Where a cable entry is intended to be used at a temperature above that foreseen in 14.7, the ageing test shall be carried out at a temperature (20 ± 5) °C above the declared maximum operating temperature of the cable. Where a cable entry is intended to be used in an ambient temperature below –20 °C, the test in the refrigerator shall be carried out at the declared minimum ambient temperature with a tolerance of ±2 K.

24 Routine verifications and tests

The manufacturer shall make the routine verifications and tests necessary to ensure that the electrical apparatus produced complies with the specification.

25 Manufacturer's responsibility

By marking the electrical apparatus in accordance with Clause 29, the manufacturer attests on his own responsibility that the electrical apparatus has been constructed in accordance with the applicable requirements of the relevant standards in safety matters, that the routine verifications and tests in Clause 24 have been successfully completed and that the product complies with the specification submitted to the testing station.

26 Verifications and tests on modified or repaired electrical apparatus

Modifications made on the electrical apparatus affecting the integrity of the type of protection or the temperature of the apparatus shall be permitted only if the modified apparatus is re-submitted to a testing station.

NOTE In the case of repairs to electrical apparatus affecting the type of protection, the parts that have been repaired should be subjected to new routine verifications and tests, which need not necessarily be made by the manufacturer.

27 Clamping tests of cable entries for non-armoured and braided cables

27.1 Cable entries with clamping by the sealing ring

27.1.1 Clamping test

Clamping tests shall be carried out using for each type of cable entry two sealing rings; one equal to the smallest admissible size and the other equal to the greatest admissible size.

27.1.2 Elastomeric sealing rings

In the case of elastomeric sealing rings for circular cables, each ring is mounted on a clean, dry, polished cylindrical mild steel mandrel equal to the smallest cable diameter allowable in the ring and specified by the manufacturer of the cable entry.

27.1.3 Non-circular cables

For non-circular cables, the ring shall be mounted on a sample of dry, clean cable of dimensions equal to the size specified by the manufacturer of the cable entry.

27.1.4 Metallic sealing rings

In the case of metallic sealing rings, each ring is mounted on a sample of clean, dry cable of a diameter equal to the smallest diameter allowable in the ring and specified by the manufacturer of the cable entry.

27.1.5 Cable slippage

The sealing ring with the mandrel or cable, as appropriate, is fitted into the cable entry. A torque is then applied to the screws (in the case of a flanged compression element fitted with screws) or to the nut (in the case of a screwed compression element) in order to obtain the compression of the sealing ring and prevent slipping of the mandrel or cable when the force applied to it is of a value, in Newtons, equal to

- twenty times the value in millimetres of the diameter of the mandrel or cable when the cable entry is designed for round cable, or
- six times the value in millimetres of the perimeter of the cable when the cable entry is designed for non-circular cable.

For test conditions and acceptance criteria see 27.4.

NOTE The torque figures referred to above may be determined experimentally prior to the tests or they may be supplied by the manufacturer of the cable entry.

27.2 Cable entries with clamping by filling compound

27.2.1 Clamping test

Clamping tests shall be carried out using two samples of clean, dry cable; one equal to the smallest admissible size and the other equal to the greatest admissible size.

27.2.2 Compound

The filling compound, prepared as stated by the manufacturer of the cable entry, is filled into the available space and the entry is submitted to the tests after the compound has hardened in accordance with the manufacturer's instructions.

27.2.3 Cable slippage

The filling compound shall prevent slippage of the cable when the force applied to it is of a value, in Newtons, equal to

- twenty times the value in millimetres of the diameter of the cable sample when the cable entry is designed for circular cable, or
- six times the value in millimetres of the perimeter of the cable sample when the cable entry is designed for non-circular cable.

27.2.4 Verification

For test conditions and acceptance criteria see 27.4.

27.3 Cable entries with clamping by means of a clamping device

27.3.1 Types of cable

The clamping test shall be carried out using, for each type of cable, entry clamping devices of different permitted sizes.

27.3.2 Samples

Each device is mounted on a sample of clean, dry cable of a diameter allowable in the device and specified by the manufacturer of the cable entry. For non-circular cables, the ring shall be mounted on the sheath of a sample of dry cable with dimensions equal to the size specified for use with the sealing ring.

27.3.3 Test set-up

The clamping device, together with the cable and the sealing ring, whose size is equal to the largest size of cable allowable in that ring and specified by the manufacturer of the cable entry, are then fitted into the cable entry. The entry is then assembled with compression of the sealing ring and tightening of the clamping device. The test procedure shall be carried out according to 27.1.

27.4 Tensile test

27.4.1 Test set-up

The prepared sample is mounted on a tensile testing machine and a constant tensile force equal to that defined above is then applied for 6 h. The test is carried out at an ambient temperature of (20 ± 5) °C.

27.4.2 Verification

The clamping assured by the sealing ring, filling compound or clamping device is acceptable if the slippage of the mandrel or cable sample is not more than 6 mm.

27.5 Mechanical strength

27.5.1 General

After the tensile test, the cable entry is removed from the tensile testing machine and submitted to the following tests and examinations, as appropriate.

27.5.2 Mechanical strength

In the case of cable entries with clamping by sealing ring or a clamping device, a mechanical strength test, on which a torque of 1,5 times the value is needed to prevent slipping, is applied to the screws or nuts (whichever is the case). The cable entry is then dismantled and the components examined. The mechanical strength of the cable entry is acceptable if no deformation affecting the type of protection is found. Any deformation of the sealing rings shall be ignored.

27.5.3 Verification of sealing ring

Where cable entries are manufactured from plastic material, if the prescribed proof torque cannot be met due to temporary deformations of the thread, and no noticeable damage is found, the cable entry shall be deemed to have passed the test.

27.5.4 Verification of compound

In the case of cable entries with clamping by filling compound, the gland is dismantled as far as possible without damaging the filling compound. Upon examination there shall be no physical or visible damage to the filling compound which would affect the type of protection afforded.

28 Clamping tests of cable entries for armoured cables

28.1 Clamping tests where the armourings are clamped by a device within the gland

28.1.1 General

The tests shall be carried out using, for each size of entry, a sample of armoured cable of the smallest size specified.

The sample of armoured cable is fitted into the clamping device of the cable entry. A torque is then applied to the screws (in the case of a flanged clamping device) or to the nut (in the case of a screwed clamping device) in order to compress the clamping device and prevent slipping of the armour when the force applied to it equals a value, in Newtons, of 20 times the value in millimetres of the diameter of the cable over the armour.

NOTE The torque value referred to in the preceding paragraph may be determined experimentally prior to the tests, or may be supplied by the manufacturer of the cable entry.

28.1.2 Tensile test

The prepared sample is mounted on a tensile testing machine and a constant tensile force equal to that defined above is then applied for 120 s ± 10 s. The test is carried out at an ambient temperature of (20 ± 5) °C.

The clamping assured by the clamping device is acceptable if the slipping of the armour is effectively zero.

28.1.3 Mechanical strength

Where screws and nuts are fitted, they shall be tightened to 1,5 times the values in 28.1.1 and then the cable entry dismantled. The mechanical strength is acceptable if no deformation affecting the type of protection is found.

28.2 Clamping tests where the armourings are not clamped by a device within the gland

The cable entry shall be treated as if of non-armoured type according to 27.1.

29 Marking

29.1 General

The electrical apparatus shall be marked on the main part in a visible place. This marking shall be legible and durable, taking into account possible chemical corrosion.

NOTE In the interest of safety, it is essential that the system of marking indicated below is only applied to electrical apparatus which complies with this standard.

29.2 Marking of all electrical apparatus

The marking shall include the following:

a) name of the manufacturer or the registered trade mark;

b) manufacturer's type identification;

c) the symbol Ex, which indicates that the electrical apparatus corresponds to one or more of the types of protection which are the subject of the specific standards listed in Clause 1;

d) the symbol for each type of protection used:
   - "pD": protection by pressurization;
   - "tD": protection by enclosure;
   - "iaD" or "ibD": protection by intrinsic safety;
   - "mD": protection by encapsulation;

e) the zone in which the apparatus can be used;

   NOTE In addition to marking the zone for enclosures complying with IEC 61241-1, the zone is prefixed with A for Practice A and B for Practice B.

f) the degree of protection (IP Code);

g) the maximum surface temperature T, marked as a temperature value;

h) where appropriate according to 5.2 the maximum surface temperature T_L shall be shown on the certificate as a temperature value, with the layer depth indicated in millimetres, or with the symbol X;

i) where appropriate according to 5.3 the marking shall include either the symbol "T_a" or "T_{amb}" together with the special range of ambient temperature or the symbol X;

j) a serial or batch number, but not required for
   - connection accessories (cable and conduit entries, blanking plates, adaptor plates, plugs and sockets and bushings),
   - very small electrical apparatus on which there is limited space;

k) where a certificate has been issued, the name or mark of the issuer and the certificate reference in the following form: the last two figures of the year of certification followed by the serial number of the certificate in that year;

l) if it is necessary to indicate special conditions for safe use, the symbol "X" shall be placed after the certificate reference. The issuer may accept the use of a warning marking as an alternative to the requirement for the "X" marking;

   NOTE The manufacturer should ensure that the requirements of the special conditions for safe use are passed to the purchaser together with any relevant information.

m) any additional marking prescribed in the specific standards for the types of protection concerned, as in Clause 1;

n) any marking normally required by the standards of construction of the electrical apparatus. This marking need not be verified by the certificate issuer.

29.3 Multiple protection techniques

Where different types of protection are used on different parts of an electrical apparatus, each respective part shall bear the symbol for the type of protection concerned.

Where more than one type of protection is used in an electrical apparatus, the symbol for the main type of protection shall appear first and shall be followed by the symbols for the other types of protection used.

29.4 Order of marking

The markings c) to h) in 29.2 shall be placed in the order in which they are given above.

29.5 Reduced marking

On very small electrical apparatus and on Ex components where there is limited space, the certificate issuer may allow a reduction in the marking but will require at least:

a) the name or registered trade mark of the manufacturer;

b) the symbol Ex and the symbol of the type of protection;

c) the name or mark of the testing station;

d) the certificate reference if applicable;

e) for electrical apparatus, the symbol "X" if appropriate; or for Ex components, the symbol "U".

30 Examples of marking

NOTE These examples do not include the marking normally required by the standards for construction of the electrical apparatus (see 29.2 n)) and any additional marking, if required by the specific standard for the type of dust explosion protection.

30.1 Apparatus type of protection "mD" for use in Zone 20

ABC company		Type RST
Serial No. 123456		
NA 01/99999		
Ex mD 20 T120°C		
V	A	Hz

NA = Name or mark of certificate issuer

30.2 Apparatus type of protection "iaD" for use in Zone 20

ABC company		Type XYZ
Serial No. 123456		
NA 01/99999		
Ex iaD 20 T120°C		
V	A	Hz

NA = Name or mark of certificate issuer

30.3 Apparatus type of protection "pD" for use in Zone 21

ABC company Type KLM
Serial No. 123456
NA 01/99999
Ex pD 21 IP65 T120°C
V A Hz

NA = Name or mark of certificate issuer

30.4 Apparatus type of protection "tD", Practice A (see IEC 61241-1); temperature tested under 500 mm dust layer, for use in Zone 21

ABC company Type RST
Serial No. 987654
NA 02/1111111
Ex tD A21 IP65 T225°C T_{500} 320°C
V A Hz
kW r/min

NA = Name or mark of certificate issuer

30.5 Apparatus type of protection "tD", Practice B (see IEC 61241-1) for use in Zone 22

ABC company Type KLM
Serial No. 123456
NA 01/99999
Ex tD B22 T170°C
V A Hz
kW r/min

NA = Name or mark of certificate issuer

30.6 Apparatus type of protection "tD", Practice A (see IEC 61241-1) for use in Zone 22

ABC company Type RST
Serial No. 987654
NA 01/99999
Ex tD A22 IP54 T120°C
V A Hz
kW r/min

NA = Name or mark of certificate issuer

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